U.S. DEPARTMENT OF COMMERCE PATENT & TRADEMARK OFFICE

E/O Form PTO-1390	**Transmittal Letter to the United States Designated/Elected Office (DO/EO/US) Concerning a Filing Under *35 USC 371***	*Attorney's Docket Number* THIE3004/JEK
	09/926408	*U.S. Application Number (if known)*
International Application Number PCT/BE00/00039	*International Filing Date* 19 April 2000	*Priority Date Claimed* 28 April 1999
Title of Invention METHOD FOR DISPLAYING IMAGES ON A DISPLAY DEVICE, AS WELL AS A DISPLAY DEVICE USED THEREFOR		
Applicant(s) for DO/EO/US Robbie THIELEMANS et al.	Assignee	

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items under *35 USC 371*:

1. ☒ This is a **FIRST** submission of items concerning a filing under *35 USC 371*.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under *35 USC 371*.
3. ☒ This express request to begin national examination procedures *(35 USC 371(f))* at any time rather than delay examination until the expiration of the applicable time limit set in *35 USC 371(b)* and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed *35 USC 371(c)(2)*.
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English *(35 USC 371(c)(2))*.
7. ☒ Amendments to the claims of the International Application under PCT Article 19 *(35 USC 371(c)(3))*
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 *(35 USC 371(c)(3))*.
9. ☒ An oath or declaration of the inventor(s) *(35 USC 371(c)(4))*. (☐ Executed ☒ Unexecuted)
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 *(35 USC 371(c)(5))*.

Items 11 to 16 below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under *37 CFR 1.97* and *1.98*.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with *37 CFR 3.28* and *3.31* is included.
13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: 3 sheets of formal drawings

Application Number (if Known)	International Application Number	Attorney's Docket Number
09/926408	PCT/BE00/00039	THIE3004/JEK

	Calculations	PTO USE ONLY
17. The following fees are submitted: **Basic National Fee *(37 CFR 1.492(a)(1)-(5))*:** ☒ Search report has been prepared by the EPO or JPO . . . . . $890.00 ☐ International Preliminary Examination Fee paid to USPTO *(37 CFR 1.482)* . . . . . $710.00 ☐ No International Preliminary Examination Fee paid to USPTO *(37 CFR 1.482)* but International Search Fee paid to USPTO *(37 CFR 1.445(a)(2))* . . . . . $740.00 ☐ Neither International Preliminary Examination Fee *(37 CFR 1.482)* nor International Search Fee *(37 CFR 1.445(a)(2))* paid to USPTO . . . . . $1040.00 ☐ International Preliminary Examination Fee paid to USPTO *(37 CFR 1.482)* and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT	**$ 890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date *(37 CFR 1.492(e))*.		

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	28 -20 =	8	× $18.00	$ 144.00	
Independent Claims	2 -3 =		× $84.00		
Multiple Dependent Claims (if applicable)			+ $280.00		
TOTAL OF ABOVE CALCULATIONS				**$ 1,034.00**	
Reduction by ½ for filing by small entity, if applicable. Small Entity Status is asserted pursuant to 37 CFR 1.27 for this application.					
SUBTOTAL				**$ 1,034.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date *(37 CFR 1.492(f))*.					
TOTAL NATIONAL FEE				**$ 1,034.00**	
Fee for recording the enclosed assignment *(37 CFR 1.21(h))*. The assignment must be accompanied by an appropriate cover sheet *(37 CFR 3.28, 3.31)*. **$40.00** per property.					
TOTAL FEES ENCLOSED				**$ 1,034.00**	
Amount to be:				Refunded:	
				Charged:	

a. ☒ A check in the amount of **$1,034.00** to cover the fees is enclosed.

b. ☐ Please charge my **Deposit Account Number 02-0200** in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to **Deposit Account Number 02-0200**. A duplicate copy of this sheet is enclosed.

Note: Where an appropriate time limit under *37 CFR 1.494* or *1.495* has not been met, a petition to revive *(37 CFR 1.137(a) or (b))* must be filed and granted to restore the application to pending status.

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DATE: 29 October 2001

Respectfully submitted,

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

International Patent Application
No. PCT/BE00/00039

PCT/DO/EO/US

International Filing Date: 19 April 2000

Applicant: Robbie THIELEMANS et al.

For: METHOD FOR DISPLAYING IMAGES ON A DISPLAY DEVICE, AS WELL AS A DISPLAY DEVICE USED THEREFOR

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

This paper accompanies documents submitted to establish the U.S. national stage of the above-identified international patent application.

The claims were not amended during the international phase. Before calculation of the filing fee and before examination, please amend the application as follows:

IN THE CLAIMS:

Please amend the original as-filed claims as shown on the appended APPENDIX OF CLAIMS, which includes amended and non-amended claims. Also appended hereto an APPENDIX OF MARKED UP CLAIMS showing the changes which have been made.

REMARKS

All rights are reserved to the original claimed subject matter. The claims have been amended to reduce the filing fees and to better conform to U.S. claim format. Examination of the application as amended is respectfully requested.

Respectfully submitted,
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APPENDIX OF MARKED UP VERSION OF CLAIMS

3(Amended). Method according to claim 1 [or 2], characterised in that use is made of display units (4) consisting of LED panels.

4(Amended). Method according to claim 1[, 2 or 3], characterised in that a distributed signal processing is provided for between the general processing unit (2) on the one hand and the individual processing units (5) on the other hand.

8(Amended). Method according to claim 5[, 6 or 7], characterised in that one or several individual adjustments are made at the general processing unit (2) related to one or several of the following possibilities:

- image stabilisation and/or noise suppression;
- tracking of the illumination of the image, in other words luminance tracking, whereby certain values of the luminance are included;
- histogram equalisation as a function of the entire image to be displayed;
- observing of what is called cue flash and acting appropriately in case of such a cue flash;
- reduction of the image in relation to the original input image in the horizontal and/or vertical direction.

9(Amended). Method according to [any of claims 4 to 8] <u>claim 4</u>, characterised in that a distributed signal processing is at least provided for the signals related to the image display, in other words a distributed image processing.

11(Amended). Method according to claim 9 [or 10], characterised in that in the individual processing units (5), one or several individual adjustments are made

which make sure that every display unit (4) operates frequency-independent vertically and horizontally.

12(Amended). Method according to claim 9, [10 or 11,] characterised in that an automatic pulse width adjustment is realised in the individual processing units (2).

13(Amended). Method according to [any of claims 9 to 12] claim 9, characterised in that a frequency raise is carried out in the individual processing units (5) to eliminate what is called surface flicker.

14(Amended). Method according to [any of claims 9 to 13] claim 9, characterised in that the line frequency is raised in the general processing unit (2) in order to eliminate what is called the interline flicker and in order to obtain a higher image resolution.

15(Amended). Method according to [any of claims 9 to 14] claim 9, characterised in that a distributed signal processing is at least provided for the signals which determine the image geometry.

17(Amended). Method according to [any of the preceding claims] claim 1, characterised in that it also provides for a dynamic image stabilisation.

19(Amended). Method according to [any of the preceding claims] claim 1, characterised in that a number of the individual processing units (5), and preferably all of them, are provided with a master clock correction.

21(Amended). Method according to [any of the preceding claims] claim 1, characterised in that use is made of LED's (9), and in that they are driven by means

of an uninterrupted current during normal operation, whereby the length of time for which the current is switched on is used as a control parameter.

25(Amended). Display device for realising the method according to [any of claims 1 to 22] claim 1, characterised in that it comprises at least a general processing unit (2); a display (3) consisting of several display units (4); an individual processing unit (5) per display unit (4); means (10) which transmit at least data concerning the image to be displayed from the general processing unit (2) to the individual processing units (5) in the form of a data stream (11); means (12) providing for a control communication between the general processing unit (2) and each of the individual processing units (5) in the form of control signals (13); and, per individual processing unit (5), means (14) which collect data from the data steam (11) as a function of the transmitted control signals (13) for further processing and display.

26(Amended). Display device according to claim 25, characterised in that it is equipped with electronic circuits which make it possible to realise one or several of the steps [2 to 22] described in [the claims] claim 1.

27(Amended). Display device according to claim 25 [or 26], characterised in that it has a modular design whereby the display units (4) are made in the form of replaceable tiles.

APPENDIX OF CLAIMS

1. Method for displaying images on a display device, characterised in that use is made of a display device (1) comprising at least a general processing unit (2), a display (3) consisting of several display units (4) and an individual processing unit (5) per display unit (4), whereby, in order to display the images, data concerning the image to be displayed are transmitted from the general processing unit (2) to the individual processing units (5) in the form of a data stream (11), in that there is a control communication between the general processing unit (2) and each of the individual processing units (5) in the form of control signals (13), and in that data from the data stream (11) are collected at every individual processing unit (5) as a function of the control signals (13) transmitted to the individual processing units (5).

2. Method according to claim 1, characterised in that use is made of display units (4) which are serially coupled.

3(Amended). Method according to claim 1, characterised in that use is made of display units (4) consisting of LED panels.

4(Amended). Method according to claim 1, characterised in that a distributed signal processing is provided for between the general processing unit (2) on the one hand and the individual processing units (5) on the other hand.

5. Method according to claim 4, characterised in that a distributed signal processing is at least provided for the signals related to the colour rendering, in other words a distributed colour processing, and/or related to the brightness and/or contrast.

6. Method according to claim 5, characterised in that one or several individual adjustments are made at the individual processing units (5) related to one or several of the following possibilities:

- adjustment of the colour co-ordinates;
- adjustment of the brightness;
- adjustment of the contrast, in particular by means of what is called 'dynamic sample weight distribution;
- corrective adjustment as a function of the temperature and/or age of the display unit (4);
- adjustment of the transfer functions RGB (red, yellow, blue);
- enlargement of the incoming video signal in the horizontal and/or vertical direction.

7. Method according to claim 6, characterised in that, in order to adjust the contrast, different modes are applied, whereby the linear connection between the input signal and the output signal is adjusted towards a non-linear connection, in each individual processing unit (5), as a function of the command which is given via the control signals (13) .

8(Amended). Method according to claim 5, characterised in that one or several individual adjustments are made at the general processing unit (2) related to one or several of the following possibilities:

- image stabilisation and/or noise suppression;
- tracking of the illumination of the image, in other words luminance tracking, whereby certain values of the luminance are included;
- histogram equalisation as a function of the entire image to be displayed;
- observing of what is called cue flash and acting appropriately in case of such a cue flash;

- reduction of the image in relation to the original input image in the horizontal and/or vertical direction.

9(Amended). Method according to claim 4, characterised in that a distributed signal processing is at least provided for the signals related to the image display, in other words a distributed image processing.

10. Method according to claim 9, characterised in that a distributed signal processing is provided for which makes sure that, both at the general processing unit (2) and at the individual processing units (5), measures are taken to minimise image flickering.

11(Amended). Method according to claim 9, characterised in that in the individual processing units (5), one or several individual adjustments are made which make sure that every display unit (4) operates frequency-independent vertically and horizontally.

12(Amended). Method according to claim 9, characterised in that an automatic pulse width adjustment is realised in the individual processing units (2).

13(Amended). Method according to claim 9, characterised in that a frequency raise is carried out in the individual processing units (5) to eliminate what is called surface flicker.

14(Amended). Method according to claim 9, characterised in that the line frequency is raised in the general processing unit (2) in order to eliminate what is called the interline flicker and in order to obtain a higher image resolution.

15(Amended). Method according to claim 9, characterised in that a distributed signal processing is at least provided for the signals which determine the image geometry.

16. Method according claim 15, characterised in that, in order to obtain a certain image geometry, control signals (13) are transmitted to the individual processing units (5) which indicate which part of the image should be displayed at the display unit (4) concerned, whereby the individual processing units (5) then collect data from the data stream (11), process them and display them, as a function of said control signals (13).

17(Amended). Method according to claim 1, characterised in that it also provides for a dynamic image stabilisation.

18. Method according to claim 17, characterised in that at least one or several of the following techniques are applied for the dynamic image stabilisation:

- a time-dependant image stabilisation, whereby it is verified for pixels of the image how alterations in time occur between successive images, and whereby an image stabilisation effect is provided for before the images are displayed;
- a frequency-dependant image stabilisation, whereby it is verified how alterations occur in pixels of the image situated next to one another, and whereby an image stabilisation effect is provided for before the images are displayed;
- an amplitude-dependant image stabilisation;
- an image stabilisation as a function of the entire image content.

19(Amended). Method according to claim 1, characterised in that a number of the individual processing units (5), and preferably all of them, are provided with a master clock correction.

20. Method according to claim 19, characterised in that different signals are used for the basic colours red/green/blue (RGB signals), and in that possible transmission errors in these RGB signals are minimised thanks to the above-mentioned master clock correction.

21(Amended). Method according to claim 1, characterised in that use is made of LED's (9), and in that they are driven by means of an uninterrupted current during normal operation, whereby the length of time for which the current is switched on is used as a control parameter.

22. Method according to claim 21, characterised in that in order to adjust the brightness, and thus the contrast, the value of the above-mentioned current is altered.

23. Method for displaying images on a display device, whereby the data for forming the successive images are transformed in signals for a display (3), characterised in that the image display is improved by evaluating the above-mentioned data and by applying a dynamic image stabilisation on the basis of this evaluation.

24. Method according to claim 23, characterised in that one or several of the following techniques are used for the dynamic image stabilisation:

- a time-dependant image stabilisation, whereby it is verified for pixels of the image how alterations in time occur between successive images, and whereby an image stabilisation effect is provided for before the images are displayed;
- a frequency-dependant image stabilisation, whereby it is verified how alterations occur in pixels of the image situated next to one another, and whereby an image stabilisation effect is provided for before the images are displayed;
- an amplitude-dependant image stabilisation;

- an image stabilisation as a function of the entire image content.

25(Amended). Display device for realising the method according to claim 1, characterised in that it comprises at least a general processing unit (2); a display (3) consisting of several display units (4); an individual processing unit (5) per display unit (4); means (10) which transmit at least data concerning the image to be displayed from the general processing unit (2) to the individual processing units (5) in the form of a data stream (11); means (12) providing for a control communication between the general processing unit (2) and each of the individual processing units (5) in the form of control signals (13); and, per individual processing unit (5), means (14) which collect data from the data steam (11) as a function of the transmitted control signals (13) for further processing and display.

26(Amended). Display device according to claim 25, characterised in that it is equipped with electronic circuits which make it possible to realise one or several of the steps described in claim 1.

27(Amended). Display device according to claim 25, characterised in that it has a modular design whereby the display units (4) are made in the form of replaceable tiles.

28. Display device according to claim 27, characterised in that it contains means which automatically recognise the position of a display unit (4) in the total image surface of the display (3).

Method for displaying images on a display device, as well as a display device used therefor.

The present invention concerns a method for displaying images on a display device, as well as a display device for realising this method.

In particular, the invention concerns display devices comprising a display which consists of several display units, whereby these display units are driven by means of a general processing unit, as well as by means of individual processing units per display unit.

In particular, it concerns display devices which make it possible to display images on a large image surface.

The invention is particularly meant for display devices comprising display units whereby the image is reproduced by means of what are called LED's (Light Emitting Diodes).

It is known that an LED wall can so to say be built in this manner. It is also known that, by building the LED wall from groups of LED's of different colours, in particular red, blue and green, by appropriately adjusting the intensity of the different LED's, it is possible to obtain various global colour effects. Also, by means of an appropriate control of the LED's, it is possible to reproduce moving images in colour, for example video images, on the LED wall.

Such display devices can be used for different purposes, for example for displaying images in stadiums, information

and/or publicity in public buildings, such as for example airports, stations, etc.

A display device with active modules is known from US 5.523.769. Data are exchanged here between a general processing unit and one central, individual processing unit, which further communicates with the other individual processing units. The different processing units can also communicate among themselves.

This known device is disadvantageous in that a large number of mutual data exchanges are required, so that the system is very restricted as far as calculation possibilities are concerned.

The invention aims a method for representing images on a display device of the above-mentioned type, whereby this method allows for a smoother data processing than according to the methods known until now.

In the first place, the method of the invention is designed for LED screens, but it can also be applied in a more general way in other display devices, such as CRT projectors and the like.

To this aim, the invention concerns a method for displaying images on a display device, characterised in that use is made of a display device comprising at least a general processing unit, a display consisting of several display units and an individual processing unit per display unit, whereby, in order to display the images, data concerning the image to be displayed are transmitted from the general processing unit to the individual processing units in the form of a data stream, in that there is a control communication between the general processing unit and each

of the individual processing units in the form of control signals, and in that data from the data stream are collected at every individual processing unit as a function of the control signals transmitted to the individual processing units.

As the data stream is offered to each of the individual processing units on the one hand, and there is a control communication on the basis of which the individual processing units are driven on the other hand, one obtains that every display unit can work independently of the other ones, requiring no communication with a central individual processing unit. As no mutual data exchange is required between the individual processing units, there will be less data transmission, making more calculation time and calculation capacity available for processing the signals in the individual processing units.

Use is preferably made of display units which are serially coupled. As a result of this, the total display can be easily composed in any size whatsoever, without a large number of electric connections being required on the back side of the display.

As already mentioned, use is preferably made here of display units consisting of LED panels.

According to the most preferred embodiment, a distributed signal processing will be provided for according to the invention between the general processing unit on the one hand and the individual processing units on the other hand. This implies that a number of calculations are made in the general processing unit, whereas a number of other calculations are made in each of the individual processing units. This requires less data exchange between the

general processing unit and the individual processing units for the drive, making calculation time available in the general processing unit, as well as transmission time for data via the data line between the general processing unit and the individual processing units which can then be used for a refined transmission of data for displaying the image.

The invention also concerns a display device for realising the above-mentioned method, characterised in that it consists at least of a general processing unit; a display consisting of several display units; an individual processing unit per display unit; means which transmit at least data concerning the image to be displayed transmitted from the general processing unit to the individual processing units in the form of a data stream; means providing for a control communication between the general processing unit and each of the individual processing units in the form of control signals; and, per individual processing unit, means which collect data from the data stream as a function of the transmitted control signals for further processing and display.

In order to better explain the characteristics of the invention, the following preferred embodiment according to the invention is described as an example only without being limitative in any way, with reference to the accompanying drawings, in which:

figure 1 schematically represents a display device according to the invention;
figure 2 represents a model of the display device in figure 1 in perspective;
figure 3 represents the part which is indicated by F3 in figure 2 to a larger scale;

figure 4 represents the back side of the module from figure 2 in perspective;
figure 5 represents the display device in the form of a block diagram;
figure 6 represents a number of histograms with reference to images to be displayed;
figure 7 schematically represents a special image geometry.

As represented in figure 1, the display device 1 according to the invention mainly consists of a general processing unit 2 and a display 3 consisting of a screen which is composed of several display units 4, whereby every display unit 4 is equipped with an individual processing unit 5.

The general processing unit 2, also called digitizer or video engine, consists of an appliance which transforms image signals, either coming from an external source or from an internal source, such as a built-in video player, into digitised signals which are suitable for the reproduction of the image on the display 3.

As represented in figures 2 to 4, the display units 4 consist of tile-shaped modules which, as represented in figure 1, can be assembled by attaching them on an appropriate supporting structure, for example a frame 6.

The modules are preferably fastened in the frame 6 in a detachable manner, for example by making use of fastening elements 7, as represented in figure 4, with which the modules can be snapped in the frame 6.

The image side 8 of the display units 4 is equipped with luminous elements, in particular LED's (Light Emitting Diodes), which are indicated hereafter in a general manner

with the reference 9, but which are indicated with the references 9A to 9E when represented in detail.

The LED's 9A and 9E are red for example, whereas the LED's 9B and 9D are green and the LED's 9C are blue. By controlling the respective LED's 9A-9E and by thus making the different colours illuminate with different intensities, it is possible to realise any colour whatsoever when seen from a distance. Every set of LED's 9 hereby forms a pixel of the images to be formed. It should be noted that such a pixel can be composed in different ways, of three colours or of a combination of different groups of LED's 9. Thus, for example, the LED's 9A-9B-9C form a group of basic colours with which all colours can be formed. The same goes for the LED's 9B-9C-9E as well as for 9D-9C-9E and 9A-9C-9D.

The invention is special in that the display device 1, as is schematically represented in figure 5, is equipped with means 10 which at least transmit data concerning the image to be displayed transmitted from the general processing unit 2 to the individual processing units 5 in the form of a data stream 11; means 12 providing for a control communication between the general processing unit 2 and each of the individual processing units 5 in the form of control signals 13; and, per individual processing unit 5, means 14 which collect data from the data stream 11 as a function of the transmitted control signals 13 for further processing and display on the image surface, in this case the LED panel, of the display unit 4 concerned.

It should be noted that the data stream 11 and the control signals 13 are only represented schematically in the diagram of figure 5 and that, in reality, the data stream 11 and the control signals 13 are not necessarily carried

via two different data lines. The data stream 11 and the control signals 13 may consist of a single pulse train in which certain intervals are reserved for the data stream 11 and other intervals are reserved for the control signals 13.

For practical reasons, however, it may be necessary to make different connections between the individual processing units 5, for example in the case where a separate data processing is provided for the different colours, for the control of the red, green and blue LED's 9 respectively, whereby it is transmitted separately per colour to the processing units 5.

Thanks to the design according to figure 5, however, it is possible to use a restricted number of electric connections between the successive display units 4, and they can be coupled serially by means of a number of electric cables 15-16, in particular twisted pairs, which are provided with multipolar connectors 17 which can be plugged in the back side of the processing units 5.

According to a special aspect of the invention, a distributed signal processing is provided for between the general processing unit 2 on the one hand and the individual processing units 5 on the other hand. This implies that a number of data are processed and calculated in the general processing unit 2, whereas a number of other data are processed and calculated in each of the individual processing units 5.

This distributed signal processing can be carried out at different levels.

According to a first aspect, a distributed signal processing of the signals related to the colour rendering is provided for, in other words a distributed colour processing. Also a distributed signal processing related to the brightness and/or contrast can hereby be provided for.

In particular, one or several adjustments are made at the general processing unit 2 related to one or several of the following possibilities:

- image stabilisation and/or noise suppression;
- tracking of the illumination of the image, in other words `luminance tracking', whereby certain values of the luminance are included;
- histogram equalisation as a function of the entire image to be displayed;
- observing of what is called cue flash and acting appropriately in case of such a cue flash;
- reduction of the image in relation to the original input image in the horizontal and/or vertical direction.

This implies that the noise suppression is done in a general manner for the entire image display.

Luminance tracking implies determining for example a fixed relation between the different colours beneath a certain luminance before the signals concerned are transmitted to the individual processing units 5.

By histogram equalisation is meant that a histogram of the entire image content is made and that an evaluation is subsequently made and, if necessary, corrections will be

made as a function thereof before the data stream 11 is transmitted to the processing units 5.

By way of illustration, figure 6 represents different curves which can be found in a histogram. H hereby represents the luminance value and I the number of times such values occur in this image. The curves represent all the pixels of the image.

In the case of an image which is generally rather grey, a curve A is obtained, a bright image produces the curve B and a dark image the curve C.

As a function of the nature of the curve, either curve A, B or C, a correction can thus be made. One possibility is that, when signals are observed indicating that the image is dark (curve C), the data stream 11 is adjusted such that the darkness is stressed, whereas when signals are observed indicating that the image is bright (curve B), the data stream 11 is adjusted such that the brightness is stressed. In case of curve A, for example, no correction is made.

The adjustments resulting from the evaluation of the histogram can also be linked to time. This implies that also alterations in the histogram for each of the successive images are detected and taken into account. In case of slow alterations, alterations in the output signal will be made less quickly, as a result of which is obtained a stabilisation effect.

What is called a cue flash is a sudden alteration of the entire image content, in other words a sudden change in the displayed image. It is clear that, at such a moment, the alteration should not be ignored. A detection of the cue flash allows for appropriate action at that moment.

In order to obtain a distributed signal processing, one or several individual adjustments are made at the individual processing units 5 as well. In particular, these adjustments concern one or several of the following possibilities:

- adjustment of the colour co-ordinates;
- adjustment of the brightness;
- adjustment of the contrast;
- corrective adjustment as a function of the temperature and/or age of the display unit 4;
- adjustment of the transfer functions RGB (red, yellow, blue);
- enlargement of the incoming video signal in the horizontal and/or vertical direction.

A number of these items will be illustrated in greater detail hereafter.

By colour co-ordinates are meant the co-ordinates in the chromaticity diagram. These co-ordinates determine what colour is visually observed, and they depend on several factors. Thus, for example they are linked to the age of the display unit 4, such that the adjustment must be made individually. However, the adjustment contributes to the general smoothness and uniformity of the colour reproduction in the image.

In order to adjust and improve the contrast, different modes are applied in the individual processing units 5, whereby the linear connection between the input signal and the output signal is adjusted towards a non-linear connection, whereby for example dark signals are further

reduced in order to make sure that the LED's 9 remain switched off in case of signals indicating that there is a very dark image part, whereas for example signals indicating that there is a bright image, are reinforced.

Thus can be obtained among others that when the viewer is situated close to the display 3, the dark passages will indeed be perceived as being dark, and any annoying flashing of the LED's 9 which can be perceived from nearby is excluded.

In particular, a dynamic sample weight distribution is applied above, whereby the individual processing units 5 are informed via the control signals 13 of what curve should be followed during the transformation of the linear course into the non-linear course, depending on the aimed effect.

This technique allows for a refined contrast rendering without requiring a large number of contrast level differences in the signal of the general processing unit 2 towards the individual processing units 5. By using different curves, it is possible to create different results, and transmitting a restricted signal from the general processing unit 2 to the individual processing units 5 will suffice to indicate to the latter what curve should be followed.

By providing for a corrective adjustment as a function of temperature and/or age per display unit 4, and thus also per individual processing unit 5, also other influences of temperature and/or age known as such are separately dealt with, and on condition that there is an appropriate control, differences between the displayed image in each of the display units 4 are excluded. Thus, it is possible to

remove display units 4 from the display 3 and to replace them at any time, without any disadvantages. It is also possible to build a display 3 of any size whatsoever, even when it contains display units 4 which have been in use for a shorter time than a number of the other display units 4. By age should in this case mainly be understood the total time during which a display unit 4 has been switched on.

The temperature correction offers the advantage that mutual deviations resulting from temperature differences, irrespective of the cause of these temperature differences, are excluded. Said temperature differences may occur for example when, for a longer length of time, only a part of the display 3 is driven so as to form an image, whereas from a certain moment on, the entire display 3 is used. Consequently, the display units 4 which have not been in use until then will not function at operating temperature, and an adjustment because of the temperature differences is advisable.

According to another aspect of the invention, also a distributed signal processing of the signals related to the image display, in other words a distributed image processing, is provided for.

An example of such distributed image processing consists in that a distributed signal processing is provided for which makes sure that, both at the general processing unit 2 and at the individual processing units 5, measures are taken to minimise image flickering.

According to the invention, the line frequency is raised to this end in the general processing unit 2 in order to eliminate what is called the interline flicker. It will be raised for example from 15 kHz to 32 kHz.

However, in the individual processing units 5, one or several individual adjustments are made which make sure that every display unit 4 operates frequency-independent vertically and horizontally. This adjustment consists for example in realising an automatic pulse width adjustment and/or in carrying out a frequency raise to eliminate what is called surface flicker.

The pulse width adjustment offers the advantage that one can for example automatically switch from a 50 Hz system to a 60 Hz system without any discontinuities being perceived in the displayed image. The automatic pulse width adjustment is preferably carried out by creating free spaces in between the pulses, whose interval is adjusted such that the entire signal becomes totally continuous.

The frequency is raised from for example 50/60 Hz to at least 100 Hz and better still to 400 Hz.

According to yet another aspect of the invention, a distributed signal processing of the signals determining the image geometry is provided for.

In order to obtain a certain image geometry, control signals 13 are hereby transmitted to the individual processing units 5 which indicate which part of the image should be displayed at the display unit 4 concerned, whereby the individual processing units 5 then collect data from the data stream 11, process them and display them, as a function of said control signals 13.

An example thereof is represented in figure 7, whereby the entire image which is normally displayed in the rectangle defined by the entire surface of the display 3, is

compressed into a triangle 18. The image B1 of the picture line 19 must hereby no longer be displayed over the distance X, but over the short distance Y. In this case, the display units 4A and 4B will not be ordered to collect data from the data stream 11 via the communication protocol which is contained in the control signals 13, whereas the display unit 4C will be ordered to collect all the image information of the image B1 from the data stream 11, and to display this image B1, of the picture line 19, over the distance Y. The general processing unit 2 hereby only gives a command, whereas the recalculation for the display of the image B1 over the distance Y is carried out in the processing unit 5 of the display unit 4C.

According to another aspect of the invention, a dynamic image stabilisation is provided for.

To this end, one or several of the following techniques are preferably used:

- a time-dependant image stabilisation, whereby it is verified for pixels of the image how alterations in time occur between successive images, and whereby an image stabilisation effect is provided for before the images are displayed, for example by ignoring or attenuating brief alterations;
- a frequency-dependant image stabilisation, whereby it is verified how alterations occur in pixels of the image situated next to one another, and whereby an image stabilisation effect is provided for before the images are displayed;
- an amplitude-dependant image stabilisation;
- an image stabilisation as a function of the entire image content.

Such an image stabilisation can be realised either exclusively at the general processing unit 2 or exclusively at the individual processing units 5, but also distributed over both.

It should be noted that the improvement of the image display by means of such a dynamic image stabilisation can also be applied in other display units 1 than those described above, namely also in display units which are not assembled from different display units 4 and which do not necessarily have to be of the LED type. Hence, as far as the dynamic image stabilisation is concerned, the invention is not restricted to the above-described display device 1, and it also extends to other display devices, including CRT projectors, picture tubes, etc.

According to a special characteristic of the invention, both the signals of the data stream 11 and the control signals 13 are successively displayed from one display unit 4 to the next, and a number of, preferably each of the individual processing units 5 is provided with a master clock correction. This implies that all the signals, at each transition to a subsequent display unit 4, are again optimally adjusted to one another, so that possible transmission errors are excluded, if not minimised.

In practice, different signals are preferably used for the basic colours red/green/blue (RGB signals), and possible transmission errors in these RGB signals are minimised thanks to the above-mentioned master clock correction, in particular a cumulation of shifts and errors resulting from what is called jitter is counteracted at the master clock.

Such a master clock correction is preferably carried out by means of a proprietary crystal clock in each of the individual processing units 5.

Practically, the LED's 9 are driven by means of an uninterrupted current during normal operation, whereby the length of time for which the current is switched on is used as a control parameter. Moreover, in order to adjust the brightness and contrast, the value of the above-mentioned current can be altered.

It is clear that the general processing unit 2 and the individual processing units 5 are equipped with the necessary electronic circuits in order to process the data as described above, in other words to realise the above-mentioned means 10, 12 and 14. Any craftsman can derive from the above-described operations how these circuits should be built.

It should be noted that the display device 1 preferably also contains means to automatically recognise the position of a display unit 4 in the total image surface. These means consist for example in that, when the processing unit 2 is switched on, it assigns the address `1' to the first display unit 4 coupled in series, the address `2' to the second one, and so on. In case of a systematic `through' coupling as represented in figure 1, and when the number of display units 4 are put in per row, as well as the number of rows of display units 4 among themselves, the processing unit 2 will automatically determine the position of each display unit 4 in the total display 3.

The invention is by no means limited to the above-described embodiment represented in the accompanying drawings; on the contrary, such a method for displaying images on a display

device, as well as the device used to this end, can be made in all sorts of variants while still remaining within the scope of the invention.

Claims.

1. Method for displaying images on a display device, characterised in that use is made of a display device (1) comprising at least a general processing unit (2), a display (3) consisting of several display units (4) and an individual processing unit (5) per display unit (4), whereby, in order to display the images, data concerning the image to be displayed are transmitted from the general processing unit (2) to the individual processing units (5) in the form of a data stream (11), in that there is a control communication between the general processing unit (2) and each of the individual processing units (5) in the form of control signals (13), and in that data from the data stream (11) are collected at every individual processing unit (5) as a function of the control signals (13) transmitted to the individual processing units (5).

2. Method according to claim 1, characterised in that use is made of display units (4) which are serially coupled.

3. Method according to claim 1 or 2, characterised in that use is made of display units (4) consisting of LED panels.

4. Method according to claim 1, 2 or 3, characterised in that a distributed signal processing is provided for between the general processing unit (2) on the one hand and the individual processing units (5) on the other hand.

5. Method according to claim 4, characterised in that a distributed signal processing is at least provided for the signals related to the colour rendering, in other words a

distributed colour processing, and/or related to the brightness and/or contrast.

6. Method according to claim 5, characterised in that one or several individual adjustments are made at the individual processing units (5) related to one or several of the following possibilities:

- adjustment of the colour co-ordinates;
- adjustment of the brightness;
- adjustment of the contrast, in particular by means of what is called `dynamic sample weight distribution';
- corrective adjustment as a function of the temperature and/or age of the display unit (4);
- adjustment of the transfer functions RGB (red, yellow, blue);
- enlargement of the incoming video signal in the horizontal and/or vertical direction.

7. Method according to claim 6, characterised in that, in order to adjust the contrast, different modes are applied, whereby the linear connection between the input signal and the output signal is adjusted towards a non-linear connection, in each individual processing unit (5), as a function of the command which is given via the control signals (13).

8. Method according to claim 5, 6 or 7, characterised in that one or several individual adjustments are made at the general processing unit (2) related to one or several of the following possibilities:

- image stabilisation and/or noise suppression;

- tracking of the illumination of the image, in other words `luminance tracking', whereby certain values of the luminance are included;
- histogram equalisation as a function of the entire image to be displayed;
- observing of what is called cue flash and acting appropriately in case of such a cue flash;
- reduction of the image in relation to the original input image in the horizontal and/or vertical direction.

9. Method according to any of claims 4 to 8, characterised in that a distributed signal processing is at least provided for the signals related to the image display, in other words a distributed image processing.

10. Method according to claim 9, characterised in that a distributed signal processing is provided for which makes sure that, both at the general processing unit (2) and at the individual processing units (5), measures are taken to minimise image flickering.

11. Method according to claim 9 or 10, characterised in that in the individual processing units (5), one or several individual adjustments are made which make sure that every display unit (4) operates frequency-independent vertically and horizontally.

12. Method according to claim 9, 10 or 11, characterised in that an automatic pulse width adjustment is realised in the individual processing units (2).

13. Method according to any of claims 9 to 12, characterised in that a frequency raise is carried out in

the individual processing units (5) to eliminate what is called surface flicker.

14. Method according to any of claims 9 to 13, characterised in that the line frequency is raised in the general processing unit (2) in order to eliminate what is called the interline flicker and in order to obtain a higher image resolution.

15. Method according to any of claims 9 to 14, characterised in that a distributed signal processing is at least provided for the signals which determine the image geometry.

16. Method according claim 15, characterised in that, in order to obtain a certain image geometry, control signals (13) are transmitted to the individual processing units (5) which indicate which part of the image should be displayed at the display unit (4) concerned, whereby the individual processing units (5) then collect data from the data stream (11), process them and display them, as a function of said control signals (13).

17. Method according to any of the preceding claims, characterised in that it also provides for a dynamic image stabilisation.

18. Method according to claim 17, characterised in that at least one or several of the following techniques are applied for the dynamic image stabilisation:

- a time-dependant image stabilisation, whereby it is verified for pixels of the image how alterations in time occur between successive images, and whereby an

image stabilisation effect is provided for before the images are displayed;

- a frequency-dependant image stabilisation, whereby it is verified how alterations occur in pixels of the image situated next to one another, and whereby an image stabilisation effect is provided for before the images are displayed;
- an amplitude-dependant image stabilisation;
- an image stabilisation as a function of the entire image content.

19. Method according to any of the preceding claims, characterised in that a number of the individual processing units (5), and preferably all of them, are provided with a master clock correction.

20. Method according to claim 19, characterised in that different signals are used for the basic colours red/green/blue (RGB signals), and in that possible transmission errors in these RGB signals are minimised thanks to the above-mentioned master clock correction.

21. Method according to any of the preceding claims, characterised in that use is made of LED's (9), and in that they are driven by means of an uninterrupted current during normal operation, whereby the length of time for which the current is switched on is used as a control parameter.

22. Method according to claim 21, characterised in that in order to adjust the brightness, and thus the contrast, the value of the above-mentioned current is altered.

23. Method for displaying images on a display device, whereby the data for forming the successive images are transformed in signals for a display (3), characterised in

that the image display is improved by evaluating the above-mentioned data and by applying a dynamic image stabilisation on the basis of this evaluation.

24. Method according to claim 23, characterised in that one or several of the following techniques are used for the dynamic image stabilisation:

- a time-dependant image stabilisation, whereby it is verified for pixels of the image how alterations in time occur between successive images, and whereby an image stabilisation effect is provided for before the images are displayed;
- a frequency-dependant image stabilisation, whereby it is verified how alterations occur in pixels of the image situated next to one another, and whereby an image stabilisation effect is provided for before the images are displayed;
- an amplitude-dependant image stabilisation;
- an image stabilisation as a function of the entire image content.

25. Display device for realising the method according to any of claims 1 to 22, characterised in that it comprises at least a general processing unit (2); a display (3) consisting of several display units (4); an individual processing unit (5) per display unit (4); means (10) which transmit at least data concerning the image to be displayed from the general processing unit (2) to the individual processing units (5) in the form of a data stream (11); means (12) providing for a control communication between the general processing unit (2) and each of the individual processing units (5) in the form of control signals (13); and, per individual processing unit (5), means (14) which

collect data from the data stream (11) as a function of the transmitted control signals (13) for further processing and display.

26. Display device according to claim 25, characterised in that it is equipped with electronic circuits which make it possible to realise one or several of the steps 2 to 22 described in the claims.

27. Display device according to claim 25 or 26, characterised in that it has a modular design whereby the display units (4) are made in the form of replaceable tiles.

28. Display device according to claim 27, characterised in that it contains means which automatically recognise the position of a display unit (4) in the total image surface of the display (3).

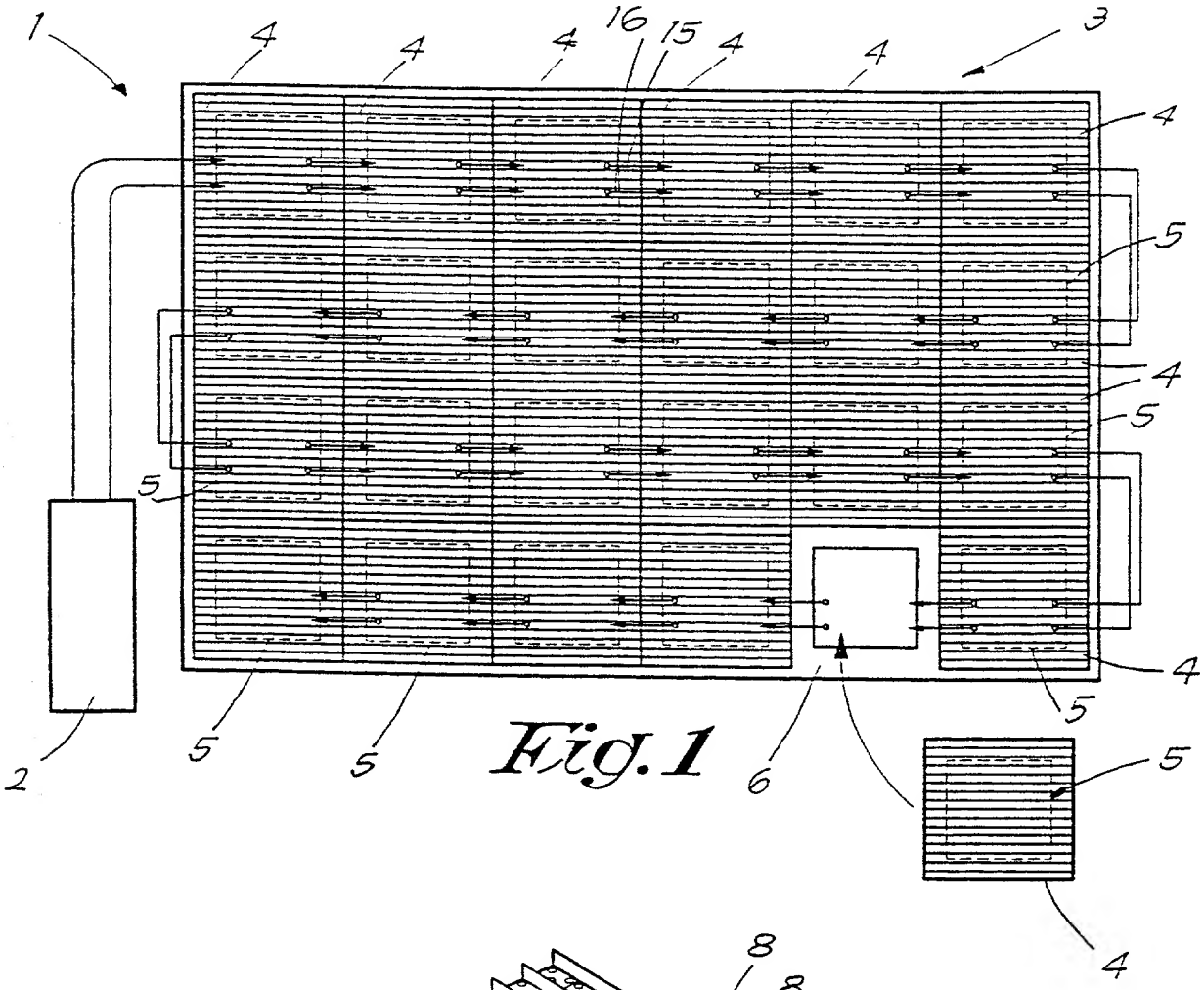

Fig. 1

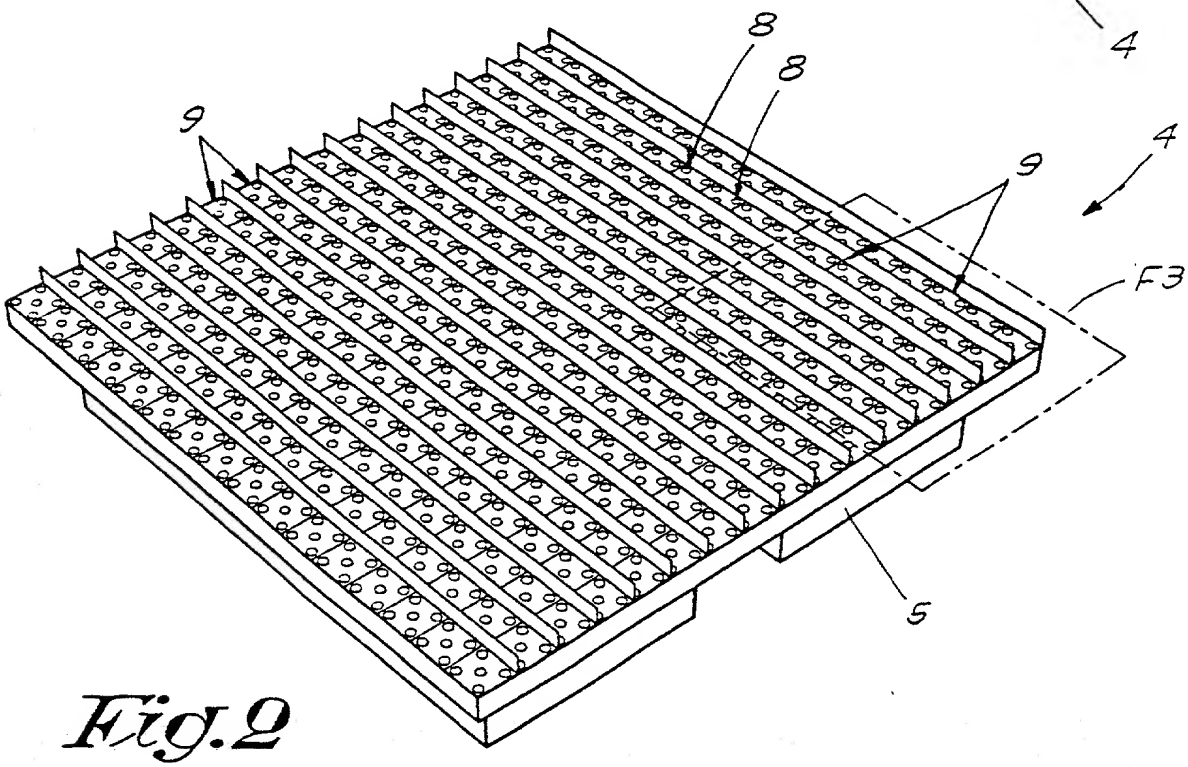

Fig. 2

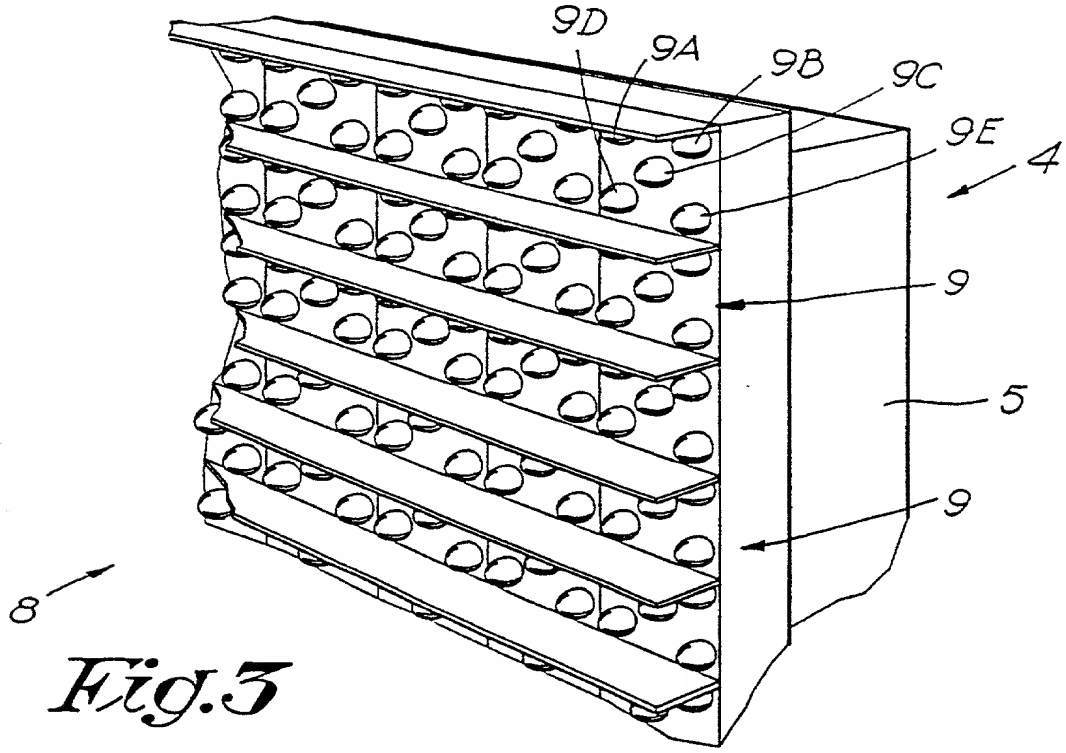

Fig.3

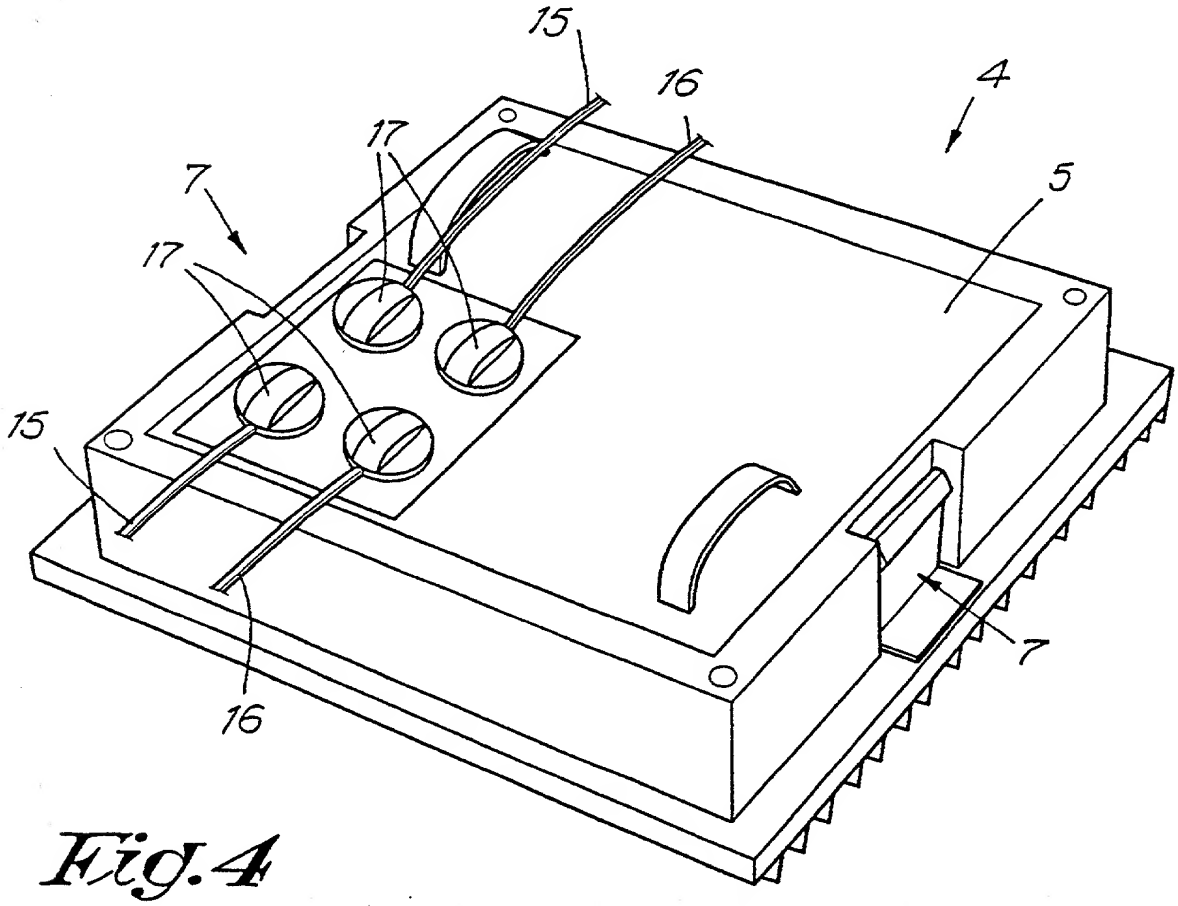

Fig.4

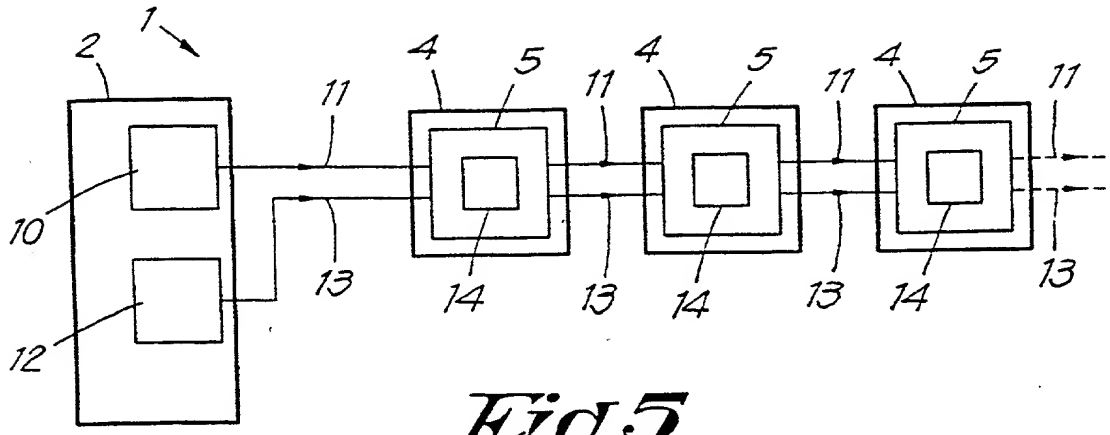

Fig.5

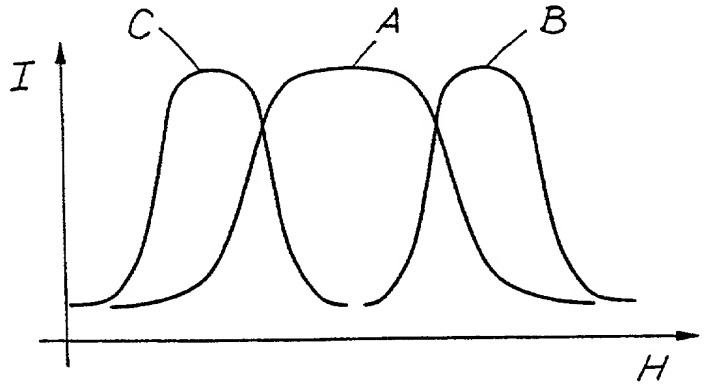

Fig.6

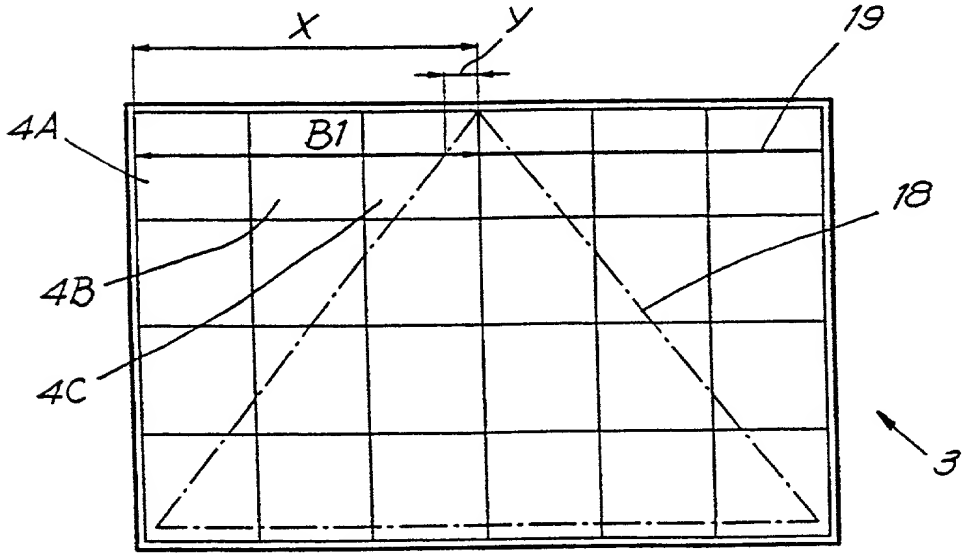

Fig.7

23364

PATENT TRADEMARK OFFICE

Attorney/Docket No. THIE3004/JEK

DECLARATION FOR PATENT APPLICATION
AND APPOINTMENT OF ATTORNEY

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name; I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention (Design, if applicable) entitled "Method of and device for displaying images on a display device"

the specification of which (check one): [ ] is attached hereto; [ ] was filed on _____ as Application Serial No. _____ and was amended on (or amended through) _____ (if applicable); was filed as International Application (PCT) No. PCT/BE 00/00039 and amended on _____ (if applicable). I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Claimed	
9900306	Belgium	28/04/1999	[X] Yes	[ ] No
(Number)	(Country)	(Day/Month/Year Filed)		
			[ ] Yes	[ ] No
(Number)	(Country)	(Day/Month/Year Filed)		
			[ ] Yes	[ ] No
(Number)	(Country)	(Day/Month/Year Filed)		
			[ ] Yes	[ ] No
(Number)	(Country)	(Day/Month/Year Filed)		

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Appln. SN)	(Filing Date)	(Status - Patented, Pending or Abandoned)
(Appln. SN)	(Filing Date)	(Status - Patented, Pending or Abandoned)

I HEREBY DECLARE THAT ALL STATEMENTS MADE HEREIN OF MY OWN KNOWLEDGE ARE TRUE AND THAT ALL STATEMENTS MADE ON INFORMATION AND BELIEF ARE BELIEVED TO BE TRUE; AND FURTHER THAT THESE STATEMENTS WERE MADE WITH THE KNOWLEDGE THAT WILLFUL FALSE STATEMENTS AND THE LIKE SO MADE ARE PUNISHABLE BY FINE OR IMPRISONMENT, OR BOTH, UNDER SECTION 1001 OF TITLE 18 OF THE UNITED STATES CODE AND THAT SUCH WILLFUL FALSE STATEMENTS MAY JEOPARDIZE THE VALIDITY OF THE APPLICATION OR ANY PATENT ISSUED THEREON.

DECLARATION FOR PATENT APPLICATION
AND APPOINTMENT OF ATTORNEY

Attorney/Docket No. _____

POWER OF ATTORNEY: I (We) hereby appoint as my (our) attorneys, with full powers of substitution and revocation, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: J. Ernest Kenney, Reg. No. 19,179; Eugene Mar, Reg. No. 25,893; Richard E. Fichter, Reg. No. 26,382; Charles R. Wolfe, Jr., Reg. No. 28,680; Bruce H. Troxell, Reg. No. 26,592; Thomas J. Moore, Reg. No. 28,974;

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Date	Signature
31-10-2001	

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City	City
State or Country Zip	State or Country Zip
Date	Signature

Full Name of Joint Inventor	Citizenship
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State or Country Zip	State or Country Zip
Date	Signature

(See following page(s) for additional joint inventors)

ATTORNEY/DOCKET NO: **THIE3004/JEK**

DECLARATION FOR PATENT APPLICATION AND APPOINTMENT OF ATTORNEY

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name; I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention (Design, if applicable) entitled:

METHOD FOR DISPLAYING IMAGES ON A DISPLAY DEVICE, AS WELL AS A DISPLAY DEVICE USED THEREFOR

the specification of which (check one):

☐ is attached hereto, or ☒ was filed on: **19 April 2000** as U.S. Application Number or PCT International Application Number: **PCT/BE00/00039** and (if applicable) was amended on:

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose information which is material to patentability as defined in *Title 37, Code of Federal Regulations, §1.56*. I hereby claim foreign priority benefits under *Title 35, United States Code §119* of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

PRIOR FOREIGN APPLICATION(S)			PRIORITY CLAIMED	
Number	Country	Day/Month/Year Filed	Yes	No
9900306	Belgium	28 April 1999	X	

☐ Additional Priority Application(s) Listed on Following Page(s)

I HEREBY CLAIM THE BENEFIT UNDER TITLE 35 U.S. CODE §119(E) OF ANY U.S. PROVISIONAL APPLICATIONS LISTED BELOW.	
Application Number	Day/Month/Year Filed

☐ Additional Provisional Application(s) Listed on Following Page(s)

I hereby claim the benefit under *Title 35, United States Code, §120* of any United States application(s) or PCT international application(s) designating The United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of *Title 35, United States Code, §112*, I acknowledge the duty to disclose information which is material to patentability as defined in *Title 37, Code of Federal Regulations, §1.56* which became available between the filing date of the prior application(s) and the national or PCT international filing date of this application:

Application Number	Filing Date	Status - Patented, Pending or Abandoned

☐ Additional US/PCT Priority Application(s) listed on Following Page(s)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under *section 1001 of title 18 of the United States Code* and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: I (We) hereby appoint as my (our) attorneys, with full powers of substitution and revocation, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: J. Ernest Kenney, Reg. No. 19,179; Eugene Mar, Reg. No. 25,893; Richard E. Fichter, Reg. No. 26,382; Thomas J. Moore, Reg. No. 28,974; Joseph DeBenedictis, Reg. No. 28,502; Benjamin E. Urcia, Reg. No. 33,805; and

I(we) authorize my(our) attorneys to accept and follow instructions from **Bureau M.F.J. Bockstael** regarding any matter related to the preparation, examination, grant and maintenance of this application, any continuation, continuation-in-part or divisional based thereon, and any patent resulting therefrom, until I(we) or my(our) assigns withdraw this authorization in writing.

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DATE	SIGNATURE

☒ *See following page(s) for additional joint inventors.*

CONTINUATION OF DECLARATION FOR PATENT APPLICATION AND APPOINTMENT OF ATTORNEY

PRIOR FOREIGN APPLICATION(S) (35 USC §119)			PRIORITY CLAIMED	
Number	**Country**	**Day/Month/Year Filed**	**Yes**	**No**

PRIOR PROVISIONAL APPLICATIONS 35 U.S. CODE §119(E)	
Application Number	**Day/Month/Year Filed**

PRIOR U.S. OR PCT INTERNATIONAL APPLICATIONS (35 U.S. CODE §120)		
Application Number	**Filing Date**	**Status - Patented, Pending or Abandoned**

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DATE	SIGNATURE

FULL NAME OF JOINT INVENTOR	CITIZENSHIP
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DATE	SIGNATURE

FULL NAME OF JOINT INVENTOR	CITIZENSHIP
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DATE	SIGNATURE

☐ *See following pages for additional joint inventors/priority applications.*